

Effect of the Cathode Carbon Structure and the Distribution of Pt and Ionomer on Improving the Performance and Durability of PEFCs

- Degradation Mechanism and Mitigation Strategy of Mesoporous Carbon-Supported Pt Catalysts during Realistic Startup and Air Confinement Shutdown -

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Achieving both high performance and durability is critical for polymer electrolyte fuel cells (PEMFCs). Mesoporous carbon (MPC) catalysts have attracted significant attention as promising materials for high-efficiency systems due to their high activity.¹ In this study, we evaluated the durability of platinum loaded carbon catalysts using MPC and Ketjen black (KB), as well as graphitized Vulcan carbon (GVC), under realistic start-up/shutdown^{2,3} (SUSD) conditions involving power generation and air containment.⁴ Comprehensive analyses, including time-resolved monitoring of CO₂ evolution and Pt dissolution, revealed that the MPC and KB catalysts were susceptible to severe performance degradation (Figs. 1 and 2). We found that MPC undergoes carbon corrosion driven by SUSD conditions, particularly in regions with limited proton access, resulting not only in mass transport issues but also severe Pt particle growth. Furthermore, we demonstrated that controlling the upper potential limit via power generation effectively mitigates this degradation by suppressing Pt oxidation and accelerating oxygen consumption, which mitigates the carbon corrosion (Fig. 2). This study identifies critical concerns regarding the long-term operation of MPC catalysts and provides a practical strategy for suppressing degradation in real-world environments.

References

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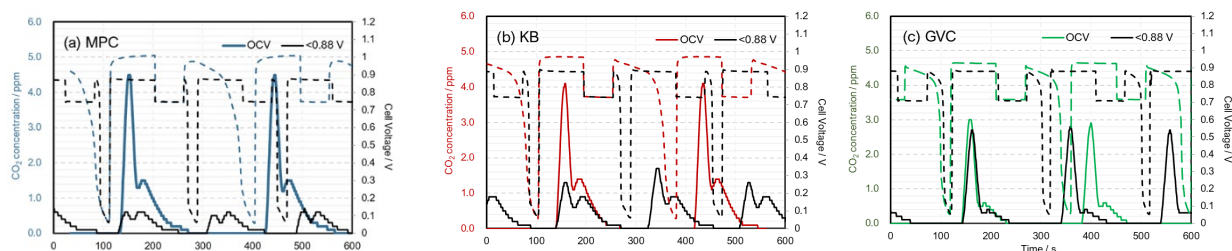


Fig. 1 Voltage fluctuation profiles (dashed lines) and CO₂ evolution peaks (solid lines) during the SUSD test for (a) MPC, (b) KB, and (c) GVC catalysts under OCV mode and < 0.88 V mode.

*The time axes of the voltage profiles are aligned with the initial voltage drop to 0 V for comparison.

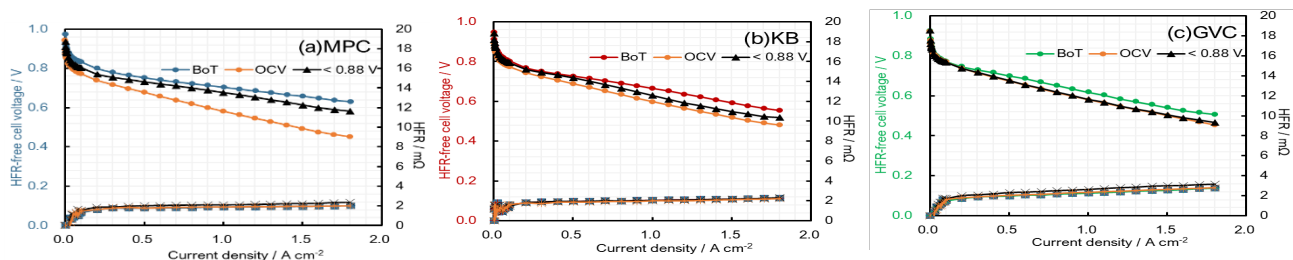


Fig. 2 *I-V* polarization curves and oxygen gain before and after the SUSD test under different potential control modes for (a) MPC, (b) KB, and (c) GVC. Measurement conditions were H₂/air (ambient pressure), 100% RH, and a cell temperature of 80°C.